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December 21, 1993

FEDERAL EXPRESS

Secretary
Federal Communications Commission
1919 M Street, N.W.
Washington, D.C. 20554

Dear Secretary:

Re: MM Docket No. 93-225

Enclosed are my Reply Comments (twelve individually-signed copies, any one of which may be considered the original) to MM Docket No. 93-225. As outlined in my letter dated December 14, 1993, this submission was delayed due to an equipment failure.

Thank you for your patience in this important matter.

Respectfully submitted,

John P. Zuehlke

John P. Zuehlke

Enc

Before the
Federal Communications Commission
Washington, D.C. 20554

In the Matter of	)	
	)	
Amendment of Part 73 of the Commission's Rules to Clarify the Definition and Measurement of Aural Modulation Limits in the Broadcast Services	)	MM Docket No. 93-225

TO: Secretary

REPLY COMMENTS ON NOTICE OF INQUIRY

Adopted: July 23, 1993; Released: August 12, 1993

I

REVIEW OF SUBMITTED COMMENTS ON NOI

The Comments submitted to the Commission's Notice Of Inquiry overwhelmingly support the following conclusions: 1) the Rules should continue to allow stations to limit their emissions on the basis of deviation measurements, and 2) the nebulous rules governing overmodulation peaks are a great source of confusion to the broadcaster as well as the manufacturer. Quite a number of respondents expressed the belief that confusion about overmodulation peaks compounded by the lack of any regulation process of, and the absence of clear standards for, modulation monitoring equipment may lead

to wide variations in modulation levels. One respondent[1] even provided detailed measurements of seventeen San Francisco Area stations indicating modulation percentages of up to 108% for a station with no subcarriers, and 121% for a station with a single 67 kHz subcarrier.

Prompted by these public Comments and the Commission's observation of the general confusion about what legally constitutes overmodulation,[2] I decided to do some limited testing on my own.

II

TEST PROTOCOL

I chose to perform one of the more demanding tests for modulation monitors that had been mandated by the Commission as a requirement for Type Approval under the pre-1983 Rules: Section 73.332(d)(4)(i). This section tests the response of the peak indicator to a 10-cycle burst of a 10 kHz sinusoidal tone at a repetition rate of one to ten bursts per second. The requirement that the peak indication persist for between 2 and 4 seconds was ignored because it seemingly applies to so-called "peak-flasher" type indicators which the digital monitors did not have.

A basic broadcasting chain was set up as shown in the block diagram of Figure 1.

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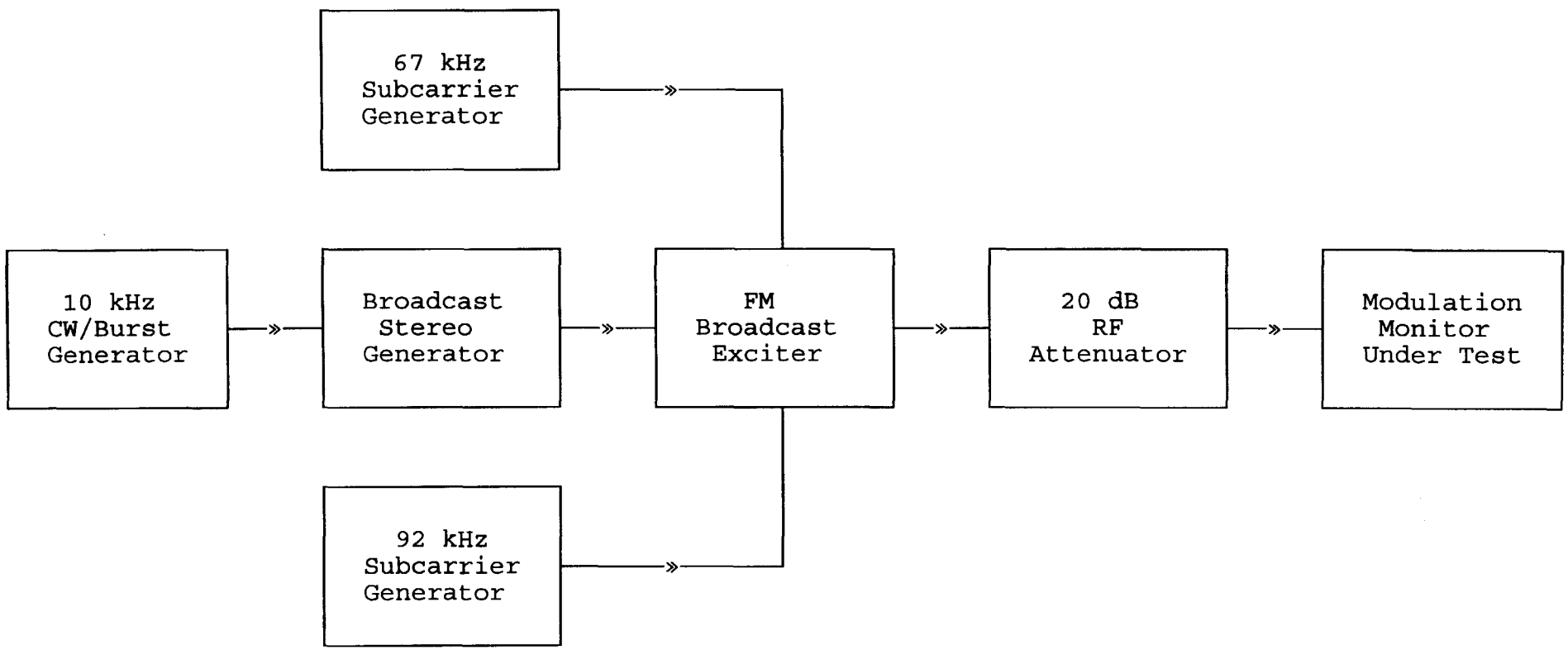
[1]Ruck, William F., Jr., NCE
[2]NOI, paragraphs 6 through 8

FIGURE 1

FM MODULATION MONITOR TESTS

BLOCK DIAGRAM



NOTES:

1. CW = Continuous wave
2. Burst = 10 cycles; 1 second repetition rate
3. Pilot injection @ 10%
4. 67 kHz and 92 kHz subcarrier injection (when used) @ 10% each
5. Subcarriers were unmodulated

With this system, two groups of tests were conducted as follows:

Test Group 1:

Conditions: a) 10% stereo pilot injection
b) No subcarriers
c) 100% total modulation (75 kHz deviation)

Tests:
1. Continuous 10 kHz tone equally to left and right channels in-phase (correct/monaural polarity).
2. As immediately above except 10-cycle burst repeated once each second.
3. Continuous 10 kHz tone to left channel only.
4. As immediately above except 10-cycle burst repeated once each second.
5. Continuous 10 kHz tone to right channel only.
6. As immediately above except 10-cycle burst repeated once each second.
7. Continuous 10 kHz tone to both channels with right channel 180-degrees out of phase (opposed polarity) from left channel.
8. As immediately above except 10-cycle burst repeated once each second.

Test Group 2:

Conditions:
a) 10% stereo pilot injection
b) 67 kHz unmodulated subcarrier injected at 10% modulation
c) 92 kHz unmodulated subcarrier injected at 10% modulation
d) 110% total modulation (82.5 kHz deviation)

Tests:
1. Continuous 10 kHz equally to left and right channels in phase (correct/monaural polarity).
2. As immediately above except 10-cycle burst repeated once each second.
3. Continuous 10 kHz tone to left channel only.
4. As immediately above except 10-cycle burst repeated once each second.
5. Continuous 10 kHz tone to right channel only.
6. As immediately above except 10-cycle burst repeated once each second.
7. Continuous 10 kHz tone to both channels with right channel 180-degrees out of phase (opposed polarity) from left channel.
8. As immediately above except 10-cycle burst repeated once each second.

The details about the 4 monitors tested are given in Appendix A.

The detailed test procedure is given in Appendix B.

III

TEST RESULTS

The Type Approved analog monitor (B1 in Table 1) and one of the non-Type Approved digital monitors (B2) gave modulation readings within a total spread of 3% regardless of whether the 10 kHz audio tone was presented continuously or as the FCC 1 ms burst test. These monitors also read consistently whether the tones were presented as monaural (L&R), left only, right only, or left 180-degrees out-of-phase with right. These two monitors also were unaffected when the two subcarriers were added and the peak modulation set at 110%.

The two other non-Type Approved monitors appear to dramatically under-read in the burst test. One read as low as 50% when the 100% modulated burst was fed individually to the left or to the right channel. It read as low as 48% when two subcarriers were added to bring the total peak modulation to 110%.

Table 1 presents the numerical findings.

It should be noted that these monitors were checked and/or calibrated using their internal calibration circuitry rather than by being calibrated against a Bessel null; accordingly no guarantee of absolute accuracy should be drawn from these findings.

TABLE 1

FM MODULATION MONITOR COMPARISON

PEAK INDICATOR TESTS

Test Sequence 1 (Pilot @ 10%; No Subcarriers)

		< < < FM MODULATION MONITOR > > >				
CHAN	10 kHz MODE	B1 (%)	B2 (%)	MM (%)	T0 (%)	T9 (%)
L+R	CW	101	100.0	100.5	104	100
L+R	Burst	102	100.3	95.0	102	86
L	CW	100	100.0	98.5	99	84
L	Burst	100	100.2	71.0	86	50
R	CW	100	100.0	98.5	99	84
R	Burst	101	100.9	71.0	87	51
L-R	CW	100	100.0	99.0	99	86
L-R	Burst	101	100.1	77.0	88	60

Test Sequence 2 (Pilot, 67 kHz & 92 kHz Subcarriers @ 10% each)

		< < < FM MODULATION MONITOR > > >				
CHAN	10 kHz MODE	B1 (%)	B2 (%)	MM (%)	T0 (%)	T9 (%)
L+R	CW	110	110.0	108.0	106	94
L+R	Burst	111	108.9	88.0	95	76
L	CW	110	110.0	105.5	101	79
L	Burst	110	107.0	71.0	81	48
R	CW	111	110.0	105.0	101	79
R	Burst	111	107.8	72.0	83	48
L-R	CW	111	110.0	106.0	101	83
L-R	Burst	111	107.9	76.0	87	56

NOTES:

1. CHAN = Channel
2. L+R = Left plus right channel
3. L = Left channel only
4. R = Right channel only
5. L-R = Left minus right channel
6. CW = Continuous wave
7. Burst = 10 cycles; 1 second repetition rate
8. Subcarriers were unmodulated

IV

CONCLUSIONS

I feel that these test results clearly illustrate the dilemma faced by the broadcaster since modulation monitors were deregulated. How much of the modulation percentage variation seen between different monitors in this demanding test would be encountered when broadcasting real-world audio signals rather than 10 kHz tone bursts? Would a station that adjusted its modulation upward due to these low-reading monitors actually exceed the occupied bandwidth allowed?

I can understand the Commission's reluctance to re-institute a Type Approval process in this era of shrinking budget and staff while facing an explosion of new technology such as digital audio broadcasting, HDTV, and the burgeoning area of wireless personal computing and communication. I do suggest that the Commission seriously consider undertaking a major clarification of the Rules at the very least, and preferably reinstituting a Certification or similar requirement for modulation monitors.

Respectfully submitted,

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December 21, 1993

APPENDIX A

MONITORS TESTED

APPENDIX A - MONITORS TESTED

1. Table 1 ID Code: B1
   Manufacturer: Belar Electronics Laboratory
   Model: FMM-2 FM Modulation Monitor
   Type: Analog monaural
   Notes: Last modulation monitor to be Type Approved.

2. Table 1 ID Code: B2
   Manufacturer: Belar Electronics Laboratory
   Model: FMMA-1 Wizard Precision Digital FM Modulation Monitor and Analyzer
   Type: Digital monaural
   Notes: a) Operated with peak weighting switched off.
   b) Used composite input derived from Belar FMM-2 detailed above.
   c) Used as reference monitor to set modulation levels.
   d) Not Type Approved.

3. Table 1 ID Code: MM
   Manufacturer: Modulation Sciences
   Model: FM ModMinder (with DeMod)
   Type: Digital monaural peak indicator
   Notes: a) Strapped into "FCC mode" for "FCC-approved measurement method."
   b) Not Type Approved.

4. Table 1 ID Codes: T0 and T9
   Manufacturer: Time and Frequency Technology (TFT)
   Model: 844A FM Stereo Modulation Monitor Analyzer
   Type: Analog stereo
   Notes: a) Used for stereo separation verification.
   b) Measured twice: Once with peak duration switch set at zero (T0), and once with peak duration switch set at nine (T9).
   c) Not Type Approved.

APPENDIX B

DETAILED TEST PROCEDURE

APPENDIX B - DETAILED TEST PROCEDURE

1. Assemble and connect the equipment per Test Setup, Figure 1. Connect the Belar Wizard in place of the "Modulation Monitor Under Test" in the test set-up to act as the reference monitor.

2. Connect the continuous/burst audio generator to drive the left and right channel inputs of the stereo generator in-phase/in correct polarity.

3. Turn on the exciter and adjust it to supply a 10-Watt RF output.

4. Verify that the modulation monitor indicates an acceptable RF input level.

5. Verify calibration (and adjust if needed) of the reference modulation monitor (Belar Wizard) by utilizing the monitor's internal reference.

6. Turn off all audio and subcarrier sources.

7. Turn on and adjust the Broadcast Stereo Generator's pilot injection to 10% total broadband modulation as indicated on the reference modulation monitor.

8. Turn on the audio generator.

9. Adjust the audio generator for a 10 kHz continuous-wave sinusoid with a frequency counter.

10. Adjust the level of the audio generator to yield a total broadband modulation of 100% as indicated on the reference modulation monitor.

11. Disconnect the reference modulation monitor.

12. Connect a stereo modulation monitor.

13. Verify that the L-R component is suppressed by a minimum of 50 dB.

14. Disconnect the stereo modulation monitor.

15. Connect the reference modulation monitor.

16. Switch the audio generator to burst mode.

17. Connect an oscilloscope's Y-axis input to output of the audio generator and its external trigger input to the pretrigger sync output on the audio generator.

18. Adjust the audio generator to produce a full 10-cycle burst of the 10 kHz signal once per second.

19. On the oscilloscope, verify that the audio gating occurs at the zero-crossing of the 10 kHz signal on both gate-on and gate-off of the burst.

20. Record the highest reading on the reference modulation monitor's peak-indicating device observed during a one-minute period.

21. Disconnect the reference modulation monitor.

22. Connect the modulation monitor to be tested.

23. Verify that the RF level is acceptable to the modulation monitor under test. Adjust the monitor's RF sensitivity if necessary.

24. Switch the audio generator to continuous mode.

25. Record the highest reading on the test modulation monitor's peak-indicating device observed during a one-minute period.

26. Switch the audio generator to burst mode.

27. Record the highest reading on the test modulation monitor's peak-indicating device observed during a one-minute period.

28. Disconnect the modulation monitor under test.

29. Repeat steps 22 through 28 for each modulation monitor to be tested.

30. Reconnect the audio generator to supply the left channel input to the stereo generator only.

31. Switch the audio generator to continuous mode.

32. Connect the reference modulation monitor.

33. Adjust the total broadband peak modulation to 100% as indicated on the reference modulation monitor.

34. Disconnect the reference modulation monitor.

35. Connect the stereo modulation monitor.

36. Verify that the right channel signal is suppressed by at least 50 dB.

37. Disconnect the stereo modulation monitor.

38. Connect the reference modulation monitor.

39. Switch the audio generator to burst mode.

40. Record the highest reading on the reference modulation monitor's peak-indicating device observed during a one-minute period.

41. Disconnect the reference modulation monitor.

42. Connect the modulation monitor to be tested.

43. Verify that the RF level is acceptable to the modulation monitor under test. Adjust the monitor's RF sensitivity if necessary.

44. Switch the audio generator to continuous mode.

45. Record the highest reading on the test modulation monitor's peak-indicating device observed during a one-minute period.

46. Switch the audio generator to burst mode.

47. Record the highest reading on the test modulation monitor's peak-indicating device observed during a one-minute period.

48. Disconnect the modulation monitor under test.

49. Repeat steps 42 through 48 for each modulation monitor to be tested.

50. Reconnect the audio generator to supply the right channel input to the stereo generator only.

51. Switch the audio generator to continuous mode.

52. Connect the reference modulation monitor.

53. Adjust the total broadband peak modulation to 100% as indicated on the reference modulation monitor.

54. Disconnect the reference modulation monitor.

55. Connect the stereo modulation monitor.

56. Verify that the left channel signal is suppressed by at least 50 dB.

57. Disconnect the stereo modulation monitor.

58. Connect the reference modulation monitor.

59. Switch the audio generator to burst mode.

60. Record the highest reading on the reference modulation monitor's peak-indicating device observed during a one-minute period.

61. Disconnect the reference modulation monitor.

62. Connect the modulation monitor to be tested.

63. Verify that the RF level is acceptable to the modulation monitor under test. Adjust the monitor's RF sensitivity if necessary.

64. Switch the audio generator to continuous mode.

65. Record the highest reading on the test modulation monitor's peak-indicating device observed during a one-minute period.

66. Switch the audio generator to burst mode.

67. Record the highest reading on the test modulation monitor's peak-indicating device observed during a one-minute period.

68. Disconnect the modulation monitor under test.

69. Repeat steps 62 through 68 for each modulation monitor to be tested.

70. Reconnect the audio generator to supply both channels to the input of the stereo generator with the right channel 180-degrees out-of-phase (inverted polarity) referenced to the left channel.

71. Switch the audio generator to continuous mode.

72. Connect the reference modulation monitor.

73. Adjust total broadband peak modulation to 100% as indicated on the reference modulation monitor.

74. Disconnect the reference modulation monitor.

75. Connect the stereo modulation monitor.

76. Verify that the L+R (baseband/monaural) signal is suppressed by at least 50 dB.

77. Disconnect the stereo modulation monitor.

78. Connect the reference modulation monitor.

79. Switch the audio generator to burst mode.

80. Record the highest reading on the reference modulation monitor's peak-indicating device observed during a one-minute period.

81. Disconnect the reference modulation monitor.

82. Connect the modulation monitor to be tested.

83. Verify that the RF level is acceptable to the modulation monitor under test. Adjust the monitor's RF sensitivity if necessary.

84. Switch the audio generator to continuous mode.

85. Record the highest reading on the test modulation monitor's peak-indicating device observed during a one-minute period.

86. Switch the audio generator to burst mode.

87. Record the highest reading on the test modulation monitor's peak-indicating device observed during a one-minute period.

88. Disconnect the modulation monitor under test.

89. Repeat steps 82 through 88 for each modulation monitor to be tested.

90. Connect the continuous/burst audio generator to drive the left and right channel inputs of the stereo generator in-phase/in-polarity.

91. Verify that the modulation monitor indicates a proper RF input level.

92. Turn off all audio and subcarrier sources.

93. Turn on and adjust the Broadcast Stereo Generator's pilot injection to 10% total broadband modulation as indicated on the reference modulation monitor.

94. Turn off the pilot.

95. Turn on the unmodulated 67 kHz subcarrier generator.

96. Verify frequency of the subcarrier generator is 67 kHz with the frequency counter.

97. Adjust the injection level of the 67 kHz subcarrier generator to 10% total broadband modulation as indicated by the reference modulation monitor.

98. Turn off the 67 kHz subcarrier generator.

99. Turn on the unmodulated 92 kHz subcarrier generator.

100. Verify frequency of the subcarrier generator is 92 kHz with the frequency counter.

101. Adjust the injection level of the 92 kHz subcarrier generator to 10% total broadband modulation as indicated by the reference modulation monitor.

102. Turn on the 67 kHz subcarrier generator.

103. Turn on the 19 kHz pilot.

104. Verify that total broadband peak modulation is 30% as indicated on the reference modulation monitor.

105. Connect the continuous/burst audio generator to drive the left and right channel inputs of the stereo generator in-phase/in correct polarity.

106. Turn on the audio generator.

107. Adjust the level of the audio generator to yield a total broadband modulation of 110% as indicated on the reference modulation monitor.

108. Disconnect the reference modulation monitor.

109. Connect the stereo modulation monitor.

110. Verify that the L-R component is suppressed by a minimum of 50 dB.

111. Disconnect the stereo modulation monitor.

112. Connect the reference modulation monitor.

113. Switch the audio generator to burst mode.

114. Record the highest reading on the reference modulation monitor's peak-indicating device observed during a one-minute period.

115. Disconnect the reference modulation monitor.

116. Connect the modulation monitor to be tested.

117. Verify that the RF level is acceptable to the modulation monitor under test. Adjust the monitor's RF sensitivity if necessary.

118. Switch the audio generator to continuous mode.

119. Record the highest reading on the test modulation monitor's peak-indicating device observed during a one-minute period.

120. Switch the audio generator to burst mode.

121. Record the highest reading on the test modulation monitor's peak-indicating device observed during a one-minute period.

122. Disconnect the modulation monitor under test.

123. Repeat steps 116 through 122 for each modulation monitor to be tested.

124. Reconnect the audio generator to supply the left channel input to the stereo generator only.

125. Switch the audio generator to continuous mode.

126. Connect the reference modulation monitor.

127. Adjust the total broadband peak modulation to 110% as indicated on the reference modulation monitor.

128. Disconnect the reference modulation monitor.

129. Connect the stereo modulation monitor.

130. Verify that the right channel signal is suppressed by at least 50 dB.

131. Disconnect the stereo modulation monitor.

132. Connect the reference modulation monitor.

133. Switch the audio generator to burst mode.

134. Record the highest reading on the reference modulation monitor's peak-indicating device observed during a one-minute period.

135. Disconnect the reference modulation monitor.

136. Connect the modulation monitor to be tested.

137. Verify that the RF level is acceptable to the modulation monitor under test. Adjust the monitor's RF sensitivity if necessary.

138. Switch the audio generator to continuous mode.

139. Record the highest reading on the test modulation monitor's peak-indicating device observed during a one-minute period.

140. Switch the audio generator to burst mode.

141. Record the highest reading on the test modulation monitor's peak-indicating device observed during a one-minute period.

142. Disconnect the modulation monitor under test.

143. Repeat steps 136 through 142 for each modulation monitor to be tested.

144. Reconnect the audio generator to supply the right channel input to the stereo generator only.

145. Switch the audio generator to continuous mode.

146. Connect the reference modulation monitor.

147. Adjust the total broadband peak modulation to 110% as indicated on the reference modulation monitor.

148. Disconnect the reference modulation monitor.

149. Connect the stereo modulation monitor.

150. Verify that the left channel signal is suppressed by at least 50 dB.

151. Disconnect the stereo modulation monitor.

152. Connect the reference modulation monitor.

153. Switch the audio generator to burst mode.

154. Record the highest reading on the reference modulation monitor's peak-indicating device observed during a one-minute period.

155. Disconnect the reference modulation monitor.

156. Connect the modulation monitor to be tested.

157. Verify that the RF level is acceptable to the modulation monitor under test. Adjust the monitor's RF sensitivity if necessary.

158. Switch the audio generator to continuous mode.

159. Record the highest reading on the test modulation monitor's peak-indicating device observed during a one-minute period.

160. Switch the audio generator to burst mode.

161. Record the highest reading on the test modulation monitor's peak-indicating device observed during a one-minute period.

162. Disconnect the modulation monitor under test.

163. Repeat steps 156 through 162 for each modulation monitor to be tested.

164. Reconnect the audio generator to supply both channels to the input of the stereo generator with the right channel 180-degrees out-of-phase (inverted polarity) referenced to the left channel.

165. Switch the audio generator to continuous mode.

166. Connect the reference modulation monitor.

167. Adjust total broadband peak modulation to 110% as indicated on the reference modulation monitor.

168. Disconnect the reference modulation monitor.

169. Connect the stereo modulation monitor.

170. Verify that the L+R (baseband/monaural) signal is suppressed by at least 50 dB.

171. Disconnect the stereo modulation monitor.

172. Connect the reference modulation monitor.

173. Switch the audio generator to burst mode.

174. Record the highest reading on the reference modulation monitor's peak-indicating device observed during a one-minute period.

175. Disconnect the reference modulation monitor.

176. Connect the modulation monitor to be tested.

177. Verify that the RF level is acceptable to the modulation monitor under test. Adjust the monitor's RF sensitivity if necessary.

178. Switch the audio generator to continuous mode.

179. Record the highest reading on the test modulation monitor's peak-indicating device observed during a one-minute period.

180. Switch the audio generator to burst mode.

181. Record the highest reading on the test modulation monitor's peak-indicating device observed during a one-minute period.

182. Disconnect the modulation monitor under test.

183. Repeat steps 176 through 182 for each modulation monitor to be tested.